CONSERVARE SALUTEM

UNITED STATES ARMY ENVIRONMENTAL HYGIENE AGENCY

ABERDEEN PROVING GROUND, MD 21010-5422

WATER QUALITY ENGINEERING CONSULTATION NO. 31-24-0676-86
IMPACT OF FIELD TRAINING ACTIVITIES
ON A SOLE-SOURCE AQUIFER
CAMP EDWARDS
BOURNE, MASSACHUSETTS
3-7 JUNE 1985

AEHA

DEPARTMENT OF THE ARMY
U.S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010-5422

REPLY TO
ATTENTION OF

HSHB-EW-R

14 March 1986

SUBJECT: Water Quality Engineering Consultation No. 31-24-0676-86, Impact of Field Training Activities on a Sole-Source Aquifer, Camp Edwards, Bourne, Massachusetts, 3-7 June 1985

Manager
ARNG Operating Activity Center
ATTN: NGB-ARI-E
Aberdeen Proving Ground, MD 21010-5420

EXECUTIVE SUMMARY

The purpose and summary of the recommendations of the enclosed report follow:

a. Purpose. To assess overall sanitation practices utilized during field training exercises at Camp Edwards and to evaluate the potential impact upon an underlying sole-source aquifer.

b. Recommendations. To ensure good environmental engineering practices, the following recommendations are made: Ensure that proper field sanitation practices are followed and that wastewater discharges emanating from field kitchen, vehicle maintenance, and personal hygiene activities are adequately and safely handled. Evaluate the effectiveness of the treatment and disposal systems at the Unit Training Equipment Site vehicle wash rack lagoon. Clean out concrete vault latrines and complete structures by building and sealing vault floors, as designed. A routine maintenance program should be established, as appropriate. Also, install monitoring wells downgradient of select latrines/latrine-clusters.

FOR THE COMMANDER:

Encl

Karl J Daubel
KARL J. DAUBEL
Colonel, MS
Director, Environmental Quality

CF:
HQDA(DASG-PSP) (wo/encl)
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Cdr, MEDDAC, Ft Devens (PVNTMED Svc) (w/encl)
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TAG, State of Massachusetts (3 cy) (w/encl)

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CAMP EDWARDS
BOURNE, MASSACHUSETTS
3-7 JUNE 1985

1. AUTHORITY. Letter, National Guard Bureau, NGB-ARI-E, 9 October 1984, subject: USAEHA Mission Services, FY 85.

2. REFERENCES. See Appendix A for a listing of references.

3. PURPOSE. This consultation was performed to assess overall sanitation practices utilized during field training exercises at Camp Edwards and to evaluate the potential impact upon an underlying sole-source aquifer.

4. GENERAL.

a. Abbreviations. See Appendix B for a listing of abbreviations.

b. Personnel Contacted. See Appendix C for a listing of personnel contacted during this consultation.

c. Mission. Camp Edwards is operated by the MARNG as a primary training site for reserve components from Massachusetts and Rhode Island but is also utilized by units located throughout the northeast region of the US. The Massachusetts Air National Guard is responsible for the operation and maintenance of facilities associated with the Otis Air National Guard Base located at Camp Edwards. The installation also houses various activities under the jurisdiction of the US Air Force, US Coast Guard, and US Marine Corps. Several other government agencies, including the Veterans Administration, Department of the Interior, and the Department of Agriculture currently maintain operational activities at Camp Edwards.

5. FINDINGS AND DISCUSSION.

a. Geology.

(1) Camp Edwards is located within the coastal plain physiographic province, which encompasses all of Cape Cod. The predominant physical features of the region - moraines and outwash plains - are the result of depositional processes associated with the last advance and retreat of

continental ice (i.e., the Laurentian ice sheet during the Wisconsin Stage of the Pleistocene Epoch). The two moraines evident at Camp Edwards are the Buzzards Bay Moraine, which trends southwest-northeast along the western border of the installation, and the Sandwich Moraine, trending in an east-west direction along the northern boundary of this facility. These regions exhibit numerous small hills and deep hollows, with maximum elevations ranging from 270-300 feet above MSL. The southern and eastern portions of Camp Edwards, classified as outwash plain, are characteristically flat (i.e., generally ranging from 100-140 feet above MSL in elevation) and pitted with kettle holes. The outwash plains are composed of stratified sand and gravel deposited by streams of glacial meltwater. Crystalline bedrock underlies the unconsolidated glacial deposits at a depth of approximately 150 feet below the surface.

(2) Soils predominant in the northern and western regions of Camp Edwards, associated with the moraines, have been classified as belonging to the Plymouth-Canton-Carver Association. This soil-type is well drained and exhibits rapid permeability through fine, loamy topsoil underlain by a gravelly, loamy sand glacial till. Characteristic of these regions, the till - which is a poorly sorted, heterogenous mixture of sand, gravel, silt, clay, and boulders which have been directly deposited by ice - is randomly mixed with areas of well-sorted and stratified sand, gravel, and silt. Agawan and Enfield Series soils comprise the material observed in the outwash plain regions to the south and east of Camp Edwards. Typical of these soils are a fine, loamy topsoil to a depth of 2 feet overlying thick sand deposits or silty materials resting atop stratified sand and gravel. The outwash plains are commonly pitted with kettle holes, which often intersect the water table. As in the moraine regions, these soils, too, are well drained and display a rapid permeability. The average permeability of soils at Camp Edwards has been determined by the USGS (Appendix A, reference 12) to be 200-300 ft/day.

b. Hydrology.

(1) As evidenced by the preceding discussion regarding the geological character of the region, no extensive confining layers exist which would inhibit the vertical or horizontal flow of ground water. The upper and lower boundaries of this single hydrologic regime, therefore, are the surface of the water table and the bedrock interface, respectively. The Cape Cod Aquifer remains a single, unconfined water source throughout the extent of Cape Cod. Camp Edwards serves as a major recharge area while being situated directly over the highest ground-water elevations (Figure). As can be observed, isopleths delineating measured ground-water elevations show that water levels range between 0 and 60 feet above MSL within the boundaries of Camp Edwards. The latter value represents the highest water elevation observed on Cape Cod. Natural recharge to this aquifer occurs entirely through precipitation/percolation - approximately half of the annual average precipitation penetrates relatively unimpeded to provide aquifer recharge. While discharge from this source is impacted to a degree naturally (e.g., evapotranspiration, direct evaporation from the water table/kettle holes, and seepage to other surface waters), the most significant percentage of withdrawal may be attributed to public and

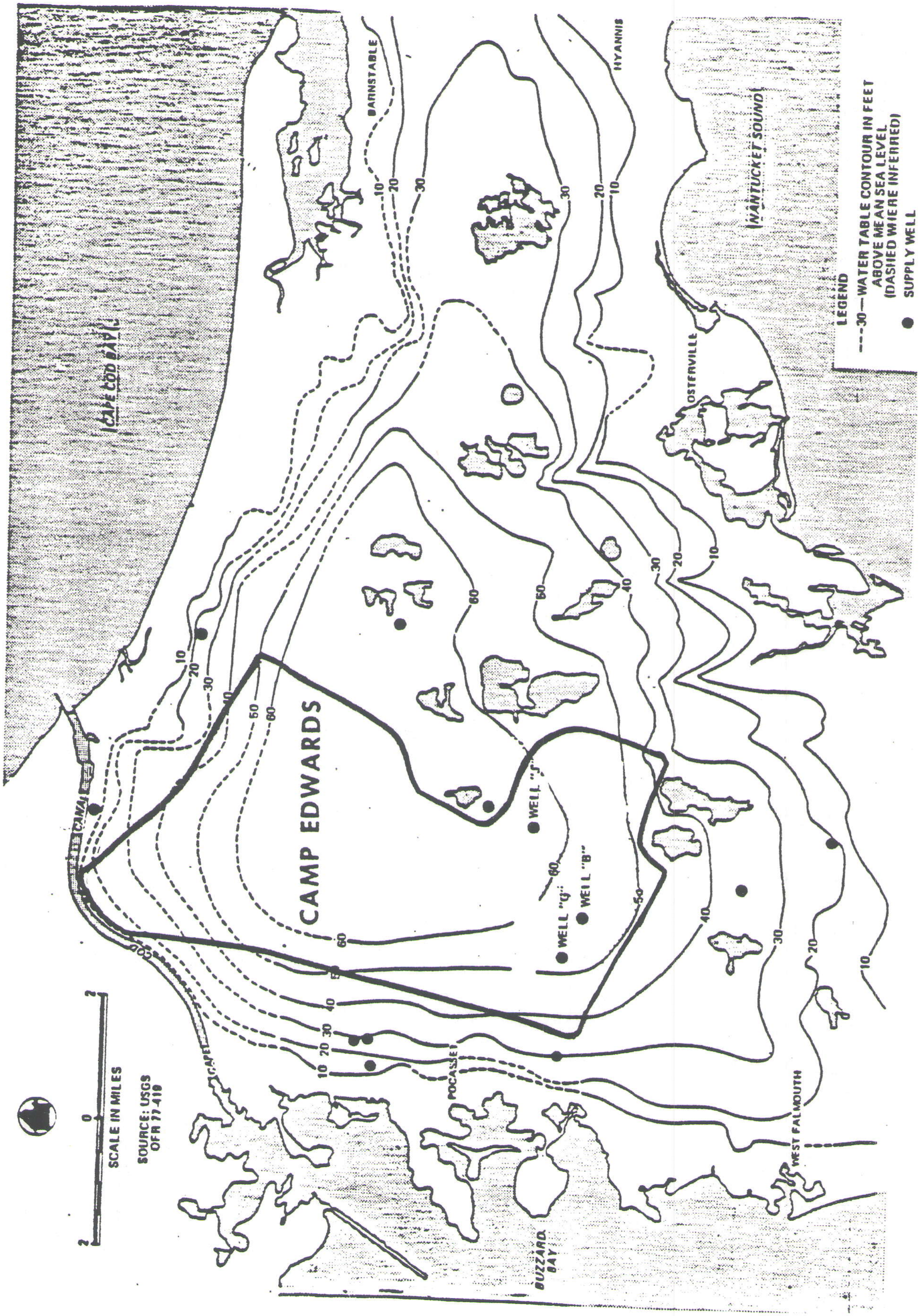

FIG. REGIONAL WATER TABLE CONFIGURATION AND SUPPLY WELLS

private potable supply wells. The aquifer receives further stress from exposure to the dynamic freshwater/saline-water interface circumscribing the Cape.

(2) There are no existing alternative potable water supplies on Cape Cod which could provide significant quantities of water to area consumers; thus, placing additional emphasis on the development/preservation of the existing aquifer. At the initial request of the Cape Cod Planning and Economic Development Commission, EPA designated the Cape Cod Aquifer as the sole or principal source of drinking water for Cape Cod in July 1982 (Appendix A, reference 5). As a result of this action, Federal financially assisted projects constructed anywhere on Cape Cod will be subject to EPA review to ensure that they are designed and constructed so as not to create a significant hazard to public health. All proposed upgrades/construction at Camp Edwards will, therefore, be subject to stringent review under the auspices of this determination.

c. Annual Field Training Exercises.

(1) At present, the MARNG Training Site is utilized intermittently throughout the spring-summer months for the annual field/range training of National Guard, regular Army, and military academy personnel. Also, routine weekend training (1 weekend per month) is often scheduled to occur at Camp Edwards throughout the year. During 1985, this facility was scheduled for 12 weeks of use beginning on 27 April and concluding on 18 August. These exercises involve the influx of soldiers and equipment from designated divisions for 2-week stints in a bivouac/training environment. Mobilization conditions are to be simulated, including the utilization of appropriate field sanitation practices. The same areas may or may not be utilized during successive operations - depending upon the types of training required and number of soldiers participating.

(2) The land surface and concomitant underlying aquifer are, therefore, temporarily stressed by such activities. Due to the nature of these training operations, and their relatively brief duration, discharge/disposal of any waste materials which might find their way into the ground-water system would be isolated and would consist of rather low volumes. Of primary concern are the practices pertaining to disposal of field kitchen/mess wastes, the maintenance and upkeep required by vehicles and equipment in the field, and personal hygiene. Approved guidelines exist for the construction and utilization of appropriate pollution abatement facilities and are documented in Appendix A, references 2, 6, and 15.

d. Field Observations. An on site evaluation of hydrogeologic character, along with a review of actual waste production and field sanitation practices implemented, was performed during the designated time frame of this consultation. The soldiers observed comprised the 3d Brigade, 26th Infantry Division of the MARNG. Sanitary practices executed were considered representative of those routinely performed during such exercises, for the purpose of assessing the potential impact upon the Cape Cod Aquifer.

(1) Field Kitchen/Mess Facilities.

(a) Waste discharge from field kitchen facilities appeared in two forms: solid (i.e., trash and garbage) and liquid (i.e., kitchen wash water). The former was collected in plastic bags and picked up daily for eventual disposal in the approved installation landfill. Liquid wastes, conversely, were to be disposed of through onsite utilization of soakage pits - which must be located a minimum of 30 yards from food service facilities, sized according to length of use (a minimum of 4 feet cubed), and filled with loose rocks to ensure that complex grease and solids are "filtered" out of the solution prior to percolation through the soil (Appendix A, reference 2). Existing conditions precluded the use of grease traps, which may be employed to minimize the clogging of soil particles.

(b) Most field kitchens/messes serviced approximately 90-115 soldiers providing two hot meals per day (i.e., breakfast and dinner). The general practice employed for cleaning cooking and eating utensils and equipment was to utilize three 40-gallon garbage cans - the first being used for a hot wash (i.e., 120 °F), while the remaining two receptacles provided duplicate rinse cycles. A packaged detergent (NSN 7930-00-530-8067) was added to the hot wash water; whereas, a strong disinfectant (NSN 6840-01-035-5432 provides equivalent of 100 mg/L of chlorine when mixed into 40 gallons of water) was introduced to either one of the rinse receptacles. The frequency of discharging the contents of these cans varied from after every meal to after three or four meals. This means that approximately 60 (average) to 240 gallons of water per day may be discharged from an individual kitchen facility. A sample was obtained from a representative hot wash receptacle (from the Brigade Headquarters kitchen) subsequent to washup from breakfast call.

(c) Soakage pits/trenches were not instituted as recommended in FM 21-10. The various units were, instead, utilizing remnants of previous battle positions (i.e., foxholes) which had been partially filled to dispose of wash and rinse waters. These holes were generally 5-30 yards from active food service tents but were seldom deeper than 6-10 inches. The holes were utilized for the entire week and responsible personnel (i.e., NCOIC's had no plans to dig additional/proper pits or fill in existing holes upon departure. Such practices served to introduce elevated concentrations of grease into the subsurface zones through direct percolation. Also, a primary concern with such shallow, improperly constructed facilities was the potential for the runoff of contaminants into adjacent surface waters. Due to the extremely rapid permeability displayed by the unconsolidated materials characteristic of the region, however, this appeared not to be a problem. Liquid migrated downward almost immediately upon introduction to the land surface.

(d) The field trains (i.e., kitchen/mess facilities) were all located in an area west of the intersection of Howe Road and Frank Perkins Road. A total of 15 separate facilities were deployed throughout this sector (A-2 on the special Camp Edwards map, series V814S, edition 2-DMA, 1975 - Appendix A, reference 16). Sited along the ridges of the Buzzards Bay Moraine at an average elevation of 180-200 feet above MSL, this placed

the field kitchens/messes a considerable distance above measured groundwater elevations (approximately 55 feet above MSL according to the USGS and Cape Cod Planning and Economic Development Commission - Appendix A, reference 18).

(2) Vehicle Wash Racks and Maintenance.

(a) Because of the relatively short duration of these field training exercises, maintenance facilities established in the field were quite limited in number and scope. Two combat train areas were organized along the east and west periphery (one each) of the training areas (sector C-16 and A-6, respectively). Vehicles were supplied with fuel and received very basic maintenance at these sites throughout the active training period. Processes/operations located within the UTES (located along Greenway Road) were utilized for more extensive maintenance and cleanup activities. This procedure ensured minimal adverse environmental impact occurring as a result of such functions.

(b) Vehicles were washed thoroughly, via high pressure hoses, at the UTES at the conclusion of the respective training period. Water was collected in a central wash rack trough, entered a small basin where solids had an opportunity to settle and surficial greases and oils were skimmed, then subsequently discharged into an adjacent percolation/evaporation lagoon. Although many contaminants (e.g., oils, grease, nutrients, metals) washed off of the vehicles remained trapped within the available treatment train, a significant portion may be entrained into the discharge pipe and enter the lagoon. Much of the sediment detected within the wash rack process was proportionately finer than that observed in surrounding undisturbed environs. These soil particles will adhere to the vehicles much stronger than coarser, larger materials. This is fortunate, with respect to containment/treatment effectiveness, as many of the contaminants mentioned will adsorb to these finer, silty particles. A large quantity of these materials will consequently settle in the wash rack basin. Further, the discharge of silty soil particles into the percolation/evaporation lagoon over a period of years has served to form an "artificial" bottom layer which aids in selectively removing many of the remaining contaminants prior to percolation into the ground water. The overall percolation rate from the lagoon is reduced, as well - causing the surface area/volume of the lagoon to increase when heavy washing occurs.

(c) Two additional categories of wastes have been identified at the UTES which may impact the Cape Cod Aquifer - fueling/defueling wastes and nonfuel wastes. A study is currently being conducted by the Waste Disposal Engineering Division of this Agency (Project No. 38-26-0500-86) to address these materials. Monitoring wells have been constructed throughout the site, with samples obtained and analyzed for fuels, hydrocarbon oils and halogenated solvents. The potential impacts of any materials detected will be addressed via that study (and ancillary followup).

(3) Personal Hygiene.

(a) The final impact to be addressed in this text emanates from personal hygiene activities. This category is comprised, primarily, of the

discharge/disposal of human waste. Logically, this concern would appear moot for several individuals in a field training/bivouac environment; however, with approximately 3,000 soldiers in the field at one time, sanitary practices and the relative concentration of soldiers in various areas must be more closely examined.

(b) Established guidelines (i.e., FM 21-10) indicate the appropriate utilization of straddle trench latrines, which are to be implemented at short-term bivouac sites (e.g., field training exercises). They should be constructed 1 foot wide by 4 feet long by 2.5 feet deep, with adjacent trenches no less than 2 feet apart. There should be a sufficient number to service 4 percent of the males and 6 percent of the females at the bivouac site. These facilities were to be located on level ground (if possible) and downgradient from campsites, food service facilities, and potable water supplies. The trenches were to be covered lightly with dirt after each use, to aid in insect/pest control. Each latrine was to be closed out when the bivouac site is moved or when the trench was filled to within 1 foot of the ground service. (Specific details for close-out procedures are also delineated in the referenced document.)

(c) Similar to kitchen wastewater disposal practices described earlier, the utilization of latrines during this annual training exercise was quite varied and, largely, not in compliance with prescribed guidelines. Where present, dug latrines were extremely shallow and overburdened. Often, they were improperly located - with respect to sleeping and mess facilities - as well. No apparent emphasis had been given the construction and maintenance of "forward" hygiene areas, according to conversations with the respective soldiers. As before, no problems with runoff from these facilities was evident due to the very rapid infiltration characteristic of the soils/geology of Camp Edwards. Prevailing conditions may not be as favorable should these soldiers be deployed in other areas of the State/nation.

(d) A total of 28 concrete vault latrines were constructed between 1981 and 1983 throughout the primary training areas to accommodate Division bivouac sites and ancillary support activities. The structures were concrete block, holding a capacity of 10-12 soldiers. According to design blueprints, the collection pit underground was also completely encapsulated by concrete blocks. The vaults were to be pumped out on an as-needed basis; with the septage trucked to the wastewater treatment facility operated by the Massachusetts Air National Guard for disposal. Despite continued heavy use during the sequence of training exercises, there was no record of any vault latrines ever being pumped out. Subsequent investigation by MARNG and Camp Edwards personnel discovered that these buildings were actually constructed without any subsurface flooring. In effect, each structure became a small percolation lagoon; however, the surface vegetative and soil layers had been short-circuited via excavation. As will be discussed below, this situation may create an adverse impact, in the form of a locally enhanced nutrient load, upon the underlying aquifer system.

e. Wastewater Characterization.

(1) Sample Locations. As indicated previously, samples were obtained from several locations during the field training exercises to facilitate quantification of the potential impact upon the Cape Cod Aquifer. Sample collection points were: a grab sample from a hot water wash container subsequent to breakfast call cleanup, a grab sample from the surface of the wash rack lagoon in the UTES area, and a grab sample from the discharge pipe leading from the wash rack collection treatment system to the lagoon. The latter sample was collected at the conclusion of the training exercise, when all vehicles were being cleaned at the UTES. The designated sample points were considered representative of activities and conditions encountered at remaining dining/mess facilities and during training exercises undertaken at this site throughout the year. Values depicting human waste were obtained from accepted textbooks (Appendix A, references 23 and 25) as a specific sample was not collected and the character of such discharge remains quite consistent. Although these figures encompass wastes and water volumes more appropriately associated with a fixed facility, they will adequately serve the needs of this evaluation.

(2) Analytical Results. Samples collected at the above locations were analyzed by the US Army Environmental Hygiene Agency. Parameters determined included BOD_5, COD, NO_2-NO_3, PO_4, and O&G. Results presented in the following Table allow an accurate characterization of wastewater entering the ground-water system and provide an opportunity for subjective evaluation of chemical uptake via soil sorption and relative infiltration into/impact upon the underlying aquifer.

f. Contaminant Uptake by Soil.

(1) A considerable number of investigations have been documented which fully detail the relative removal of contaminants migrating through various soil-types. These studies have involved the laboratory and full-scale application of wastewater through the utilization of reproduced soil columns and the land disposal of domestic wastes, respectively. Generally, most contaminants are readily removed within the top several feet of soil. The predominant forces responsible for this phenomenon are bacterial degradation and the sorptive capabilities of the soil particles. Critical factors for the effectiveness of both processes are the presence of oxygen (i.e., aerobic conditions) and the relative size, grade and polarity of soil materials. Limited aerobic conditions are found with increasing depth, which reduce the potential for biological degradation and the oxidation of sorbed materials. Also, somewhat better removal may be achieved with increasing silt fractions, as greater surface area for biological activity and greater sorptive capacity exists.

(2) Of primary importance when considering the land application of domestic wastewaters is the uptake/migration of nutrients (e.g., nitrate/nitrite/ammonia/organic nitrogen and organic/orthophosphate/total phosphate-phosphorous). These materials are commonly removed within the top several feet of soil via adsorption to soil particles. Removal efficiencies are much greater when fine-grained, colloidal particles are present. Nitrogenous materials (often in an ammonia or organic form) are attracted to charged, silty soils laden with organic matter (Appendix A, references 22 and 25). A portion of the ammonia and organic forms may be

TABLE. CHARACTERIZATION OF WASTEWATER DISCHARGED DURING ANNUAL FIELD TRAINING EXERCISES AT CAMP EDWARDS, MASSACHUSETTS (all values presented in mg/L)

Sample Location	COD	BOD_5	NO_2-NO_3 (as N)	Total PO_4 (as P)	O&G
Field mess-hot wash receptacle	34.0	2.4	0.61	0.11	2.0
Wash rack lagoon (surface)	2050.0	210.0	1.0	3.4	192.0
Wash rack lagoon (discharge pipe)	124.0	6.4	1.5	0.62	*
Personal hygiene (theoretical)	150.0 -500.0	220.0	0	5.0	100.0

* Sample lost in laboratory.

oxidized to the nitrate form for further utilization by vegetation or migration toward the water table aquifer (Appendix A, reference 19). The sorption of phosphorous compounds tends to occur rapidly at first due to sorption in mineral surfaces; however, the subsequent uptake of these materials continues quite slowly and is often the result of coprecipitation with other elements (Appendix A, reference 24). Laboratory and field experiences have shown that the sorptive capacity of soil is quickly utilized, and may be rejuvenated only through the implementation of alternating wet and dry periods - allowing phosphorous-based materials to oxidize into their elemental or mineral form (Appendix A, references 19 and 21). If an equilibrium, or saturation, point is achieved within the upper soil layers, further uptake will be precluded and increased concentrations will likely be detected within the underlying saturated zones.

(3) The organic loading upon the hydrogeological system may be approximated by examining the parameters of BOD_5 and COD. The general consensus among investigators is that the materials responsible for these demands are effectively removed within the top 3-10 feet of soil within all systems examined (Appendix A, references 19, 20, 21 and 25). Biological degradation occurring within the surficial aerobic zone eliminates BOD_5, while COD is removed through adsorption onto soil particles. Neither parameter has been observed above background levels during any of the referenced studies (which includes geological characteristics similar to those evident at Camp Edwards). Filtration/adsorption accomplished by the soil, along with an extensive anaerobic environment (i.e., depths of approximately 60 feet), would serve to preclude the migration of pathogens, as well; negating concern for these organisms in such ground-water systems.

(4) A paucity of documentation exists describing the uptake/migration of O&G through soil columns. Oil and grease are, generally, very hygroscopic; therefore, it is anticipated that materials introduced at the surface would attach rapidly to soil particles. Experience dictates that O&G materials will not migrate much beyond 5-10 feet. Increased removal efficiencies are, once again, associated with the presence of fine-grained soil particles.

g. Data Evaluation.

(1) Contaminants quantified in the Table would warrant considerable concern if the discharges occurred on a consistent, long-term basis. Instead, many of the wastes addressed in this investigation are randomly applied to the land surface over a large portion of Camp Edwards. Also, such discharges are emitted during a relatively brief portion of the year (e.g., 12 weeks out of 52 weeks during 1985). This practice allows the natural sorptive and biodegradation capabilities of the loamy surficial soils to readily remove contaminants prior to reaching the underlying saturated zone. Possible exceptions to this evaluation may occur with respect to the UTES wash rack lagoon and the concrete vault latrines. Contaminant concentrations observed have been comparable to, or less than, the influent levels measured in the documented land application studies. Although extensively monitored, contaminant concentrations remained basically at background levels in all similar cases.

(2) The literature cited previously describes the necessity of controlling influent, to a land treatment system to provide alternating wet and dry cycles, to facilitate continuous nutrient/contaminant uptake. This

procedure has not proven critical for the prolonged operation of the wash rack lagoon. The carryover of fine-grained sediment (i.e., silt) into the lagoon has created an "artificial" bottom layer which not only provides additional sorptive sites for contaminant uptake, but effectively retards downward migration, as well. This is evidenced by the elevated concentrations of materials detected in the sample obtained from the lagoon surface and the continued expansion of the lagoon (i.e., increasing surface area versus a declining water level anticipated within the lagoon). Existing treatment and disposal practices at this site need to be evaluated to determine their adequacy and acceptability. For efficient operation, the collection and treatment phases should be optimized and a permanent lagoon site(s) utilized. The former situation would minimize the carryover of contaminants and sediment to the lagoon. Wastewater and sludge would be collected and discharged to the sanitary sewer system. Also, a definition of lagoon boundaries is required to obviate uncontrolled expansion and utilization of land resources.

(3) The current construction and operation of the concrete vault latrines may be cause for some concern, as well. The placement of the vault portion of the structure required the excavation of surficial soils, which are greatly responsible for contaminant removal/uptake. While virtually all BOD_5, COD, pathogens, and O&G would still be satisfactorily reduced, it is possible that significant quantities of nutrients may migrate into the underlying ground-water system subsequent to prolonged use. These structures are heavily used during the designated training periods; however, once again, the duration of the training "season" is quite limited. This would serve to buffer any continuous slugs of contaminants entering the hydrogeologic system but would not preclude the possible introduction of limited contamination. In the future - as programmed in the installation master plan (Appendix A, reference 10) - it is intended that such training exercises will be conducted throughout the year. These plans may pose a somewhat greater risk than is currently experienced. Although it is extremely difficult to quantify the contamination entering the ground water via this source, the fact that any potential exists is cause for remediation. In this case, the situation can be mitigated only by cleaning out the vault area of each latrine and properly constructing and sealing floors, as initially designed. Once completed, appropriate operation and maintenance practices should be implemented, as well. In lieu of undertaking this amelioration plan, monitoring wells installed downgradient of two or three latrines/latrine-clusters (receiving greater use) should be utilized to indicate the potential impact upon the underlying ground-water source. Contact the State, USGS, and/or this Agency for further assistance with this matter and an appropriate routine sampling plan.

(4) Installation and MARNG authorities must recognize that everything disposed of on the land surface at Camp Edwards may very rapidly be realizing an adverse impact upon the underlying Cape Cod Aquifer. Due to their geographical location and the geological character of the region, they are custodians of the major recharge zone for this valuable resource. They must, therefore, ensure that overall operation and maintenance practices (e.g., minimization of spillage of fuel and cleaning agents; adequate treatment, segregation and/or disposal of wastes) are strictly administered and adhered to during the accomplishment of their mission goals.

6. CONCLUSION. The boundaries of Camp Edwards encompass the major recharge zone for the Cape Cod Aquifer, which has been designated a sole source aquifer by EPA. It has been determined, through the utilization of limited quantified data and subjective evaluation, that the land application of wastes during field training exercises at Camp Edwards has posed a negligible impact upon the underlying aquifer system. Contaminants are effectively diminished due to biodegradation and sorption processes occurring within the upper few feet of soil. Several potential problem areas - involving general field sanitation practices, the incomplete treatment and disposal of wastes at the UTES vehicle wash rack, and the concrete vault latrines - have been identified with remedial actions delineated where appropriate.

7. RECOMMENDATIONS. The following recommendations are based on good engineering practices.

a. Ensure that field sanitation practices, as described in FM 21-10, are closely followed - with respect to soakage pits and latrines, in particular.

b. Discharge hot wash and warm rinse waters at field kitchen facilities subsequent to every meal, where possible/practical.

c. Evaluate the effectiveness of the treatment and disposal systems at the UTES wash rack lagoon. Upgrade facilities to optimize contaminant and sediment removal and contain expansion, as discussed in text.

d. Clean out vault areas of concrete vault latrines and construct floors in each, as designed. Ensure these structures are properly sealed, and that routine maintenance occurs, as appropriate.

e. Install monitoring wells downgradient of selected, heavily used latrines/latrine-clusters to determine potential contaminant migration into ground water.

8. TECHNICAL ASSISTANCE. Requests for services should be directed through appropriate command channels of the requesting activity to the Commander, US Army Environmental Hygiene Agency, ATTN: HSHB-EW, Aberdeen Proving Ground, MD 21010-5422, with an information copy furnished the Commander, US Army Health Services Command, ATTN: HSCL-P, Fort Sam Houston, TX 78234-6000.

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Water Quality Engr Consultation No. 31-24-0676-86, Camp Edwards, Bourne, MA, 3-7 Jun 85

APPENDIX A

REFERENCES

1. AR 40-5, 1 June 1985, Preventive Medicine.

2. FM 21-10, 22 December 1983, Field Hygiene and Sanitation.

3. TM 5-700, July 1967, Field Water Supply.

4. Proposed Rule, Water Programs, Sole or Principal Source Aquifer Areas, 42 FR 51620, 29 September 1977.

5. Final Rule, Cape Cod Aquifer Determination, 47 FR 30282, 13 July 1982.

6. Report, US Army Construction Engineering Research Laboratory, June 1976, subject: Technical Report E-80 - Vehicle Washing Operations and Wastewater Discharge, Fort Drum, NY - Findings and Recommendations.

7. Report, DRXTH, US Army Toxic and Hazardous Materials Agency, September 1982, subject: Installation Restoration Program, Phase I - Records Search, Otis Air Force Base.

8. Letter, HSHB-ES/WP, this Agency, 11 April 1984, subject: Hazardous Waste Management Survey No. 37-26-0330-84, National Guard Bureau, Camp Edwards, Massachusetts, 19-23 September 1983.

9. Report, HSHB-ES, this Agency, undated, subject: Ground-Water Monitoring Plan, UTES Site and PDO Yard, Massachusetts ARNG, Camp Edwards, Massachusetts, Project No. 38-26-0500-85.

10. Report, MARNG, February 1985 (revised), subject: Camp Edwards Military Reservation - Master Plan.

11. Report, MARNG, June 1985, subject: Camp Edwards Military Reservation - Environmental Assessment.

12. Report, USGS, August 1980, Cape Cod Aquifer, Cape Cod, Massachusetts, Water Resources Investigations 80-571.

13. Report, USDA, Soil Conservation Service, December 1980, Soils and Their Interpretations for Various Land Uses - Camp Edwards.

14. Report, USGS, presented at the Toxic Waste Technical Meeting in Tuscon, Arizona on 20-22 March 1984, Open-File Report 84-475 - Movement and Fate of Solutes in a Plume of Sewage-Contaminated Ground Water.

15. Letter, US Army Corps of Engineers, DAEN-ECE-G, 5 September 1985, subject: Engineer Technical Letter 1110-3-365 - Vehicle Maintenance Facilities and Pollution Control (Vehicle Maintenance Cleaning and Servicing).

Water Quality Engr Consultation No. 31-24-0676-86, Camp Edwards, Bourne, MA, 3-7 Jun 85

16. Special Map, Defense Mapping Agency, 1975, Series V814S, Edition 2-DMA, Camp Edwards (1:25,000).

17. Special Map, The Commonwealth of Massachusetts Military Division - MARNG, December 1978 (with pen-and-ink revisions, 1983), Series V814S, Edition 1-DMATC, Camp Edwards.

18. Special Map, Cape Cod Planning and Economic Development Commission, 1982, Bourne-Sandwich Water Table Contours and Public Water Supply Well Zones of Contribution.

19. Aulenbach, Donald B., EPA-Office of Research and Development, March 1979, Long-Term Recharge of Trickling Filter Effluent into Sand, EPA-600/2-79-068.

20. Benham-Blair & Affiliates, Inc. and Engineering Enterprises, Inc., EPA-Office of Research and Development, August 1979, Long-Term Effects of Land Application of Domestic Wastewater: Milton, Wisconsin, Rapid Infiltration Site, EPA-600/2-79-145.

21. Koerner, Ernest L. and D. Alan Haws, EPA-Office of Research and Development, March 1979, Long-Term Effects of Land Application of Domestic Wastewater: Vineland, New Jersey, Rapid Infiltration Site, EPA-600/2-79-072.

22. Lance, J. C., 1972, Nitrogen Removal by Soil Mechanisms, Journal Water Pollution Control Federation, Vol 44, No. 7, pp 1352-1361.

23. Metcalf and Eddy, Inc., 1979, Wastewater Engineering: Treatment, Disposal, Reuse, 2d Edition, pp 920.

24. Sawhney, B. L., 1977, Predicting Phosphate Movement through Soil Columns, Journal of Environmental Quality, Vol 6, No. 1, pp 86-89.

25. Tare, Vinod and S. D. Bokil, 1982, Wastewater Treatment by Soils: Role of Particle-Size Distribution, Journal of Environmental Quality, Vol 11, No. 4, pp 596-601.

26. Vaccaro, R. F. et al, EPA-Office of Research and Development, August 1979, Wastewater Renovation and Retrieval of Cape Cod, EPA-600/2-79-176.

APPENDIX B

ABBREVIATIONS

BOD_5	Biochemical Oxygen Demand measured over a 5-day period
COD	Chemical Oxygen Demand
EPA	US Environmental Protection Agency
°F	degrees Farenheit
FR	Federal Register
ft/day	feet per day
MARNG	Massachusetts Army National Guard
mg/L	milligrams per liter
MSL	mean sea level
as N	measured as nitrogen
NCOIC	noncommissioned officer-in-charge
NO_2-NO_3	nitrite-nitrate
O&G	oil and grease
as P	measured as phosphorous
PO_4	phosphate
USDA	US Department of Agriculture
USGS	US Geological Survey
UTES	Unit Training Equipment Site

APPENDIX C

PERSONNEL CONTACTED

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